UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

HYDRAULIC MODEL STUDY OF THE PENSTOCK AND OUTLET DIVERSION CHANNELS--PALISADES DAM--PALISADES PROJECT

Hydraulic Laboratory Report No. Hyd-345

ENGINEERING LABORATORIES BRANCH

DESIGN AND CONSTRUCTION DIVISION
DENVER, COLORADO

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Laboratory Report No. Hyd-345
Hydraulic Laboratory
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Subject: Hydraulic model study of the penstock and outlet diversion channels--Palisades Dam--Palisades Project

PURPOSE

To record water surface profiles along the walls that line the penstock diversion channel between Stations 17+44 and 19+00, using three temporary deflector wall lengths, and to obtain photographs depicting the flow conditions between these stations in the penstock and outlet diversion channels.

Note: This is an interim report pertaining only to the concluding phases of the diversion study. The information is intended as a guide for making diversions through the channels during construction.

THE INVESTIGATION

Description of Model

The model used for this study was constructed to a scale of 1 to 61.82. It represented all of the 26-foot diameter outlet tunnel, the 26-foot diameter penstock tunnel, the diversion channel linings, the outlet-works stilling basin, and a section of the downstream river channel. The three lengths of the deflector wall studied on the model for the right side of the penstock diversion channel were constructed of sheet metal of sufficient height to prevent overtopping by flow from the tunnel. The right wall of the outlet diversion channel was constructed to a height representing elevation 5400. The top portion was a wooden strip equivalent to 10 feet in height (Wall A, Figure 1A). Tests on the two channels were not conducted during the same period, therefore some parts of the model not relative to the channel under test are not correctly represented in the photographs of the attached figures. The diverging sections of both walls of the outlet diversion channel and the left wall of the penstock channel between approximately Stations 17+85 and 18+37 were not included in the model, instead the two adjacent wall sections were extended to meet at about Station 18+00. This small difference in wall alinement on the model would have negligible influence on the flow conditions in the channel since it is in an eddy region of relatively low velocity.

Flow Conditions in Outlet Channel

Although the tunnel discharge was concentrated in the center of the outlet channel, the flow in the downstream portion of the channel was fairly uniform but rather turbulent. The water surface near the midpoints of the side walls reached an approximate maximum elevation of 5393 for a discharge representing 26,000 cfs. (Figure 1A). Flow conditions were quite similar for smaller discharges.

Flow Conditions in Penstock Channel

In the initial tests on the penstock diversion channel it was found necessary to place a temporary deflector wall on the right side immediately upstream of Station 18+90.42 to guide the water to the left and into the outlet-works stilling basin. The height of the water adjacent to the wall changed depending upon the wall angle relative to the penstock tunnel center line. Water surface profiles and photographs were obtained from the model using three deflector wall angles to illustrate the effect of the wall angle on flow conditions in the channel (Figures 1, 2, 3, and 4). The discharges used on the model represented prototype flows of 13,000, 18,000, and 23,000 cfs. The flow was quite turbulent in all cases with the stream from the penstock impinging on the deflector wall and on the raised portion of the channel floor at Station 18+83.92, causing local rises in the water surface along both walls of the channel. In general, the smaller the angle of the deflector wall with respect to the tunnel center line, the lower the water surface elevation along both walls. The maximum height of water along the left wall occurred between Stations 18+80 and 19+00, approximately, for all flows while the region of maximum water surface along the left wall moved upstream as the angle of the deflector wall decreased. With the short deflector wall (Wall No. 1, Figure 4D), this region of higher water surface was in the vicinity of Station 18+50; with the intermediate wall (Wall No. 2, Figure 4D) this region moved upstream to approximately Station 18+15; while with the long wall (Wall No. 3, Figure 4D), the region of higher water surface was near Station 17+90. The water surfaces shown on Figure 4 are for maximum heights of "solid" water so any spray from the turbulent water will be above the profiles shown on this figure.

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A. Outlet diversion--Discharge 26,000 cfs

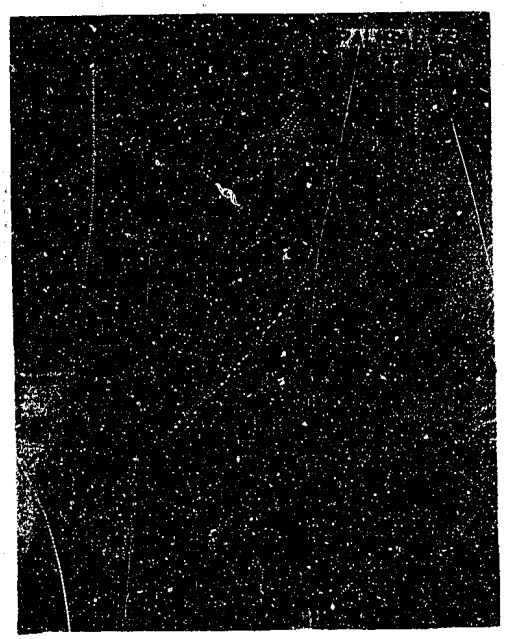
B. Penstock diversion--Deflector wall 1--Discharge 13,000 cfs

C. Penstock diversion Deflector wall 1--Discharge 18,000 cfs

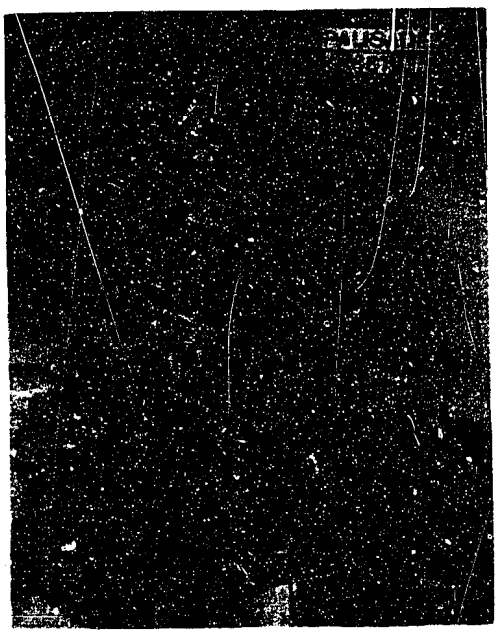
D. Penstock diversion--Deflector wall 1--Discharge 23,000 cfs.

**Flow Conditions in Diversion Channels
Palisades Dam**

A. Discharge of 13,000 cfs



B. Discharge of 18,000 cfs



C. Discharge of 23,000 cfs

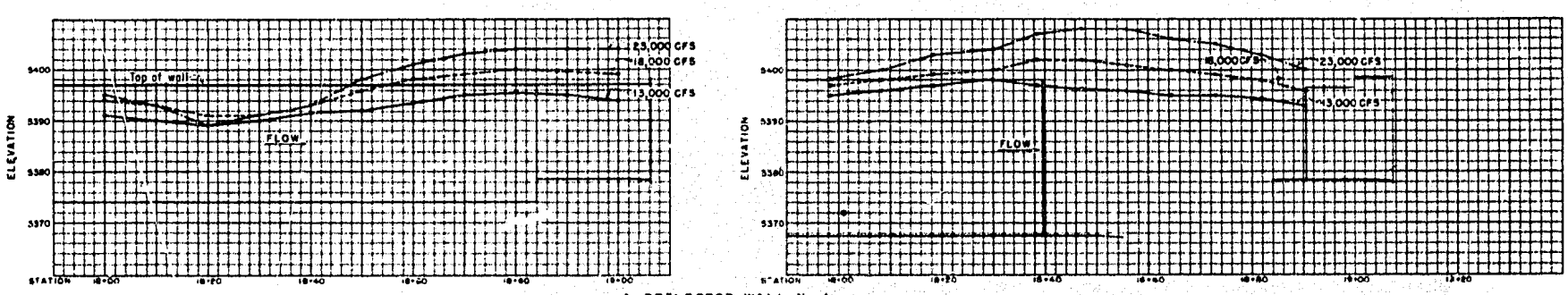
Flow Conditions with Deflector Wall 2
Penstock Diversion Channel
Palisades Dam

A. Discharge of 13,000 cfs

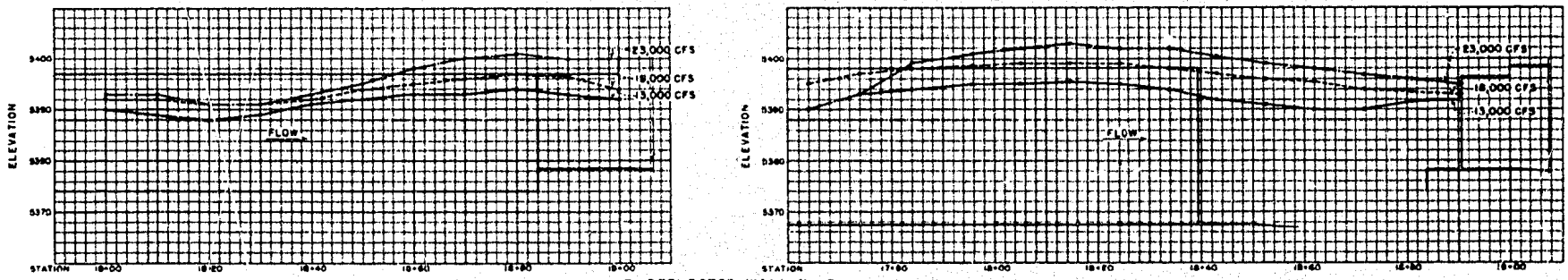
B. Discharge of 18,000 cfs

C. Discharge of 23,000 cfs

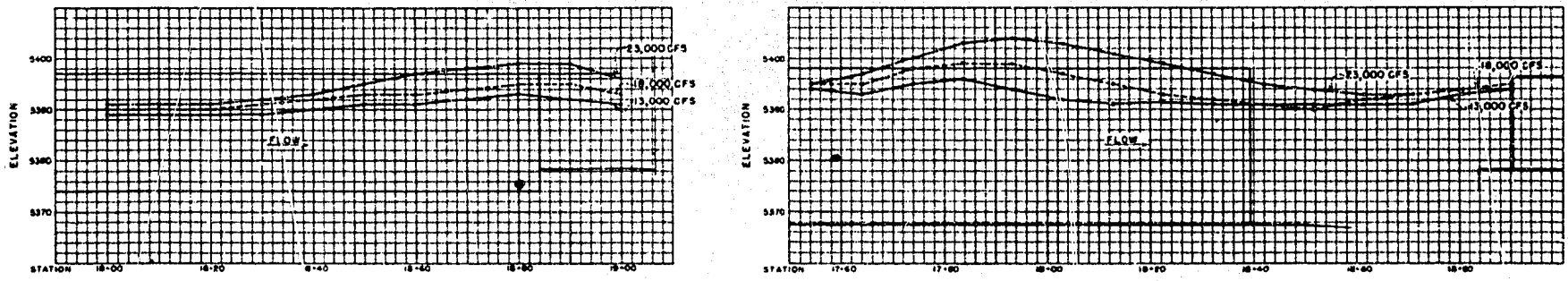
Flow Conditions with Deflector Wall 3
Penstock Diversion Channel
Palisades Dam



A. DEFLECTOR WALL No. 1



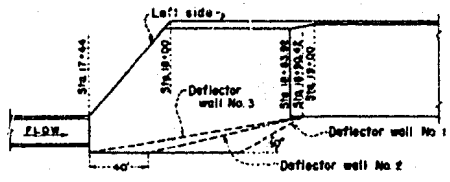
B. DEFLECTOR WALL No. 2



C. DEFLECTOR WALL No. 3

DIVERSION CHANNEL LEFT SIDE

DIVERSION CHANNEL RIGHT SIDE



D. DEFLECTOR WALL LOCATION

NOTES

Sufficient wall height was used on the model to prevent overtopping
Stationing is distance along penstock centerline
Data from 1 to 61.82 scale model.

MAXIMUM WATER SURFACE PROFILES
PENSTOCK DIVERSION CHANNEL LINING

PALISADES DAM

FIGURE 4
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